DOCUMENT RESUME

ED 254 998 EC 172 050

AUTHOR Scruggs, Thomas E.; And Others
TITLE Increasing Content-Area Learning: A Comparison of Mnemonic and Visual-Spatial Direct Instruction.
PUB DATE 85
NOTE 44p.; Paper presented at the Annual Meeting of the American Educational Research Association (69th, Chicago, IL, March 31-April 4, 1985).
PUB TYPE Speeches/Conference Papers (150) -- Reports - Research/Technical (143)

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS Elementary Education; Junior High Schools; *Learning Disabilities; *Learning Processes; Memory; *Mnemonics

ABSTRACT

In two experiments, learning disabled (LD) students were taught attributes of North American minerals via mnemonic instruction, free study, or a visual-spatial display condition similar to that proposed by Engelmann and Carnine (1982). In the first experiement, 36 junior high school-age LD students were taught specific attribute values (hardness = 1, 2, 3, etc.; color = pink, green, etc.; use = radios, acid, jewelry, etc.). In the second experiment, 36 elementary-age students were taught dichotomous attribute classifications (hard vs. soft; pale vs. dark; home vs. industrial use). In both experiments, students learned significantly more information in the mnemonic condition, and students in the visual-spatial condition did not statistically exceed free-study students in total amount learned. (Author)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

U.S. DEPARTMENT OF EDUCATION
NATIONAL INSTITUTE OF EDUCATION
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)
☒ This document has been reproduced as received from the person or organization originating it.
☐ Minor changes have been made to improve reproduction quality.
• Points of view or opinions stated in this document do not necessarily represent official NIE position or policy.

ED254998

Increasing Content-Area Learning: A Comparison of Mnemonic and Visual-Spatial Direct Instruction

Thomas E. Scruggs and Margo A. Mastropieri
Utah State University

Joel R. Levin
University of Wisconsin

Barbara McLoone
Arizona State University

Janet S. Gaffney
University of Mississippi

Maryanne Prater
Utah State University

Running head: CONTENT-AREA LEARNING

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY
Thomas E. Scruggs
TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

Paper presented at the Annual Meeting of the American Educational Research Association (69th, Chicago, IL, March 31-April 4, 1985)

Abstract

In two experiments, learning disabled (LD) students were taught attributes of North American minerals via mnemonic instruction, free study, or a visual-spatial display condition similar to that proposed by Engelmann and Carnine (1982). In the first experiment, 36 junior high school-age LD students were taught specific attribute values (hardness = 1, 2, 3, etc.; color = pink, green, etc.; use = radios, acid, jewelry, etc.). In the second experiment, 36 elementary-age students were taught dichotomous attribute classifications (hard vs. soft; pale vs. dark; home vs. industrial use). In both experiments, students learned significantly more information in the mnemonic condition, and students in the visual-spatial condition did not statistically exceed free-study students in total amount learned.

Increasing Content-Area Learning: A Comparison of Mnemonic and Visual-Spatial Direct Instruction

The direct instruction model, as proposed by Engelmann and his colleagues, has had a long and successful history in both remedial and special education (see, for example, Becker, Engelmann, Carnine & Maggs, 1982; Carnine & Silbert, 1979). Initial efforts were with disadvantaged populations (Becker, 1977), whereas later efforts were with special and remedial education populations (Gersten, 1983). In addition, some programmatic research has been conducted that has generally favored direct instruction over both "eclectic" methods and perceptual training (e.g., Lloyd, Cullinan Heins, & Epstein, 1980).

Sharing elements of the instructional model proposed by Rosenshine (1979)--which includes direct questioning of content and teaching to specific goals--direct instruction incorporates what Scruggs, Mastropieri, Levin, and Gaffney (in press) have termed the "three operant R's": responding, reinforcement, and repetition. Responding refers to the direct question-and-answer paradigm characteristic of direct instruction materials. Reinforcement refers to corrective feedback, verbal praise for correct learner responding, and the use of redeemable tokens and points for appropriate behavior. Repetition refers to the fact that direct instruction methods and materials typically rely upon

repeated rote rehearsal as the dominant learning strategy.

One major benefit of rehearsal as a learning strategy is that it can be easily adapted to virtually any content area. A disadvantage of rehearsal as a strategy is that it has been demonstrated experimentally over the past 20 years that rote repetition is one of the least efficient strategies in promoting learning and retention (e.g., Jensen & Rohwer, 1963; Martin, Boersma, & Cox, 1965; Mastropieri, Scruggs, & Levin, 1983; Pressley & Levin, 1977; Raugh & Atkinson, 1975; Rohwer, Raines, Eoff, & Wagner, 1977; Scruggs & Mastropieri, in press).

Until recently, rehearsal has been the major strategy used in SRA published materials for teaching vocabulary and science facts. For example, the following approach is given for teaching the meaning of the vocabulary word indolent: "Indolent means lazy. What does indolent mean? (Repeat until firm)." (Engelmann, Haddox, Hanner, & Osborne, 1978, p. 45). More recently, visual-spatial displays have been touted by direct instruction advocates as being optimally suited for the teaching of "fact systems" in a variety of content domains (Engelmann & Carnine, 1982; Engelmann, Davis, & Davis, 1981). Such displays are basically figural representations of fact systems, making use of what Levin (1981) has called the "organizational" function of pictures. These encompass "semantic maps" (e.g., Johnson & Pearson, 1978), "networks" (e.g., Dansereau & Holley, 1982), and figural

taxonomies used for displaying superordinate, subordinate and coordinate relationships within a particular factual classification system (e.g., vertebrates, metals, vehicles). According to Engelmann & Carnine (1982): ".. the communication of facts that are related to a topic are [sic] most efficiently communicated through a visual-spatial display that shows the coordinate relationships of entries, higher-order relationships, and important 'details'" (p. 344).

To date, however, there is little empirical evidence to support the efficacy of visual-spatial displays and closely related techniques. For example, Levin, Johnson, Pittelman, Hayes, Levin, Shriberg, and Toms-Bronowski (1984) found that semantic mapping was not very effective for helping children acquire the meanings of classifiable vocabulary items. With regard to acquiring science facts and relationships, studies by Darch and Carnine (1981) and Sprick (1979) have yielded modest support for the use of visual-spatial displays. The potential of visual-spatial displays for handicapped learners has yet to be explored. Such was the purpose of the present study.

In contrast to visual-spatial displays, which serve an organizational function, are mnemonic strategies, which serve a "transformational" function (Levin, 1981). That is, whereas visual-spatial displays impose some degree of organization on seemingly unrelated facts, the focus of mnemonic strategies is to

transform difficult-to-remember facts into a more memorable form. Mnemonic strategies encompass a variety of classical techniques and devices that have been found--both through folklore and empirical research--to enhance memory substantially. Pressley, Levin, and Delaney (1982) have described a variety of successful applications of mnemonic strategies with nonhandicapped learners. Only recently, however, have these strategies been implemented with handicapped learners, and the results have been extremely encouraging (e.g., Mastropieri, Scruggs, & Levin, 1985; Mastropieri, Scruggs, Levin, Gaffney, & McLoone, in press; Mastropieri, Scruggs, McLoone, & Levin, 1985; Scruggs, Mastropieri, & Levin, in press; Scruggs, Mastropieri, Levin, & Gaffney, in press).

Drawing upon previous work with the keyword method (Atkinson & Raugh, 1975), these researchers have used complex mnemonic strategies to teach science-related fact systems to learning-disabled (LD) students. For example, to teach that the mineral apatite is No. 5 on Moh's hardness scale, is brown in color, and is used for making fertilizer (Scruggs, Mastropieri, Levin, & Gaffney, in press), students were first taught a "keyword" for apatite. A keyword is a familiar concrete word that is acoustically similar to the unfamiliar stimulus. For this example, ape is a good keyword for apatite because it sounds like the first syllable and is easily pictured. Then, students were

taught rhyming "pegwords" for the numbers 1 through 10, where 1 is bun, 2 is shoe, 3 is tree, etc. In the case of apatite, 5 is hive. Finally, students were shown an interactive illustration of a brown ape pouring a bag of fertilizer on a beehive (see Figure 1). Students were then

---

Insert Figure 1 about here

---

provided with a direct retrieval route for all of the factual information associated with the mineral apatite. In contrast to the three operant R's of direct instruction, the "three mnemonic R's" (Levin, 1981) proved more effective. These three mnemonic R's include: recoding, where the unfamiliar stimulus term is recoded into a more familiar, concrete proxy (e.g., apatite = ape); relating, where the recoded stimulus is related to the to-be-learned information via an interactive episode (here, a picture of a brown ape pouring fertilizer over a hive); and retrieving, where the learner is provided with a direct retrieval route from the stimulus (apatite) to all of the associated information (brown, 5, fertilizer). In this, as well as in other investigations, mnemonic instruction proved to be superior to all control conditions (including direct instruction and free study).

Although mnemonic instruction has been more effective than the basic direct-instruction approach (Engelmann et al., 1978),

comparisons of mnemonic instruction with direct instruction incorporating visual-spatial displays (Engelmann & Carnine, 1982) have not yet been made. The purpose of the present investigation was to compare directly these two teaching strategies in samples of LD students. In Exp. 1 we examined the use of a direct-instruction visual-spatial strategy by students learning specific science facts, whereas in Exp. 2 we examined the use of such strategies by students learning dichotomous classifications, and extended the research into the elementary grades. In both experiments, a visual-spatial display condition was compared with both mnemonic and free-study conditions.[1] The switch from learning specific facts (Exp. 1) to classifications (Exp. 2) was made to explore the possibility that visual-spatial displays would be differentially effective for different forms of content learning.

Experiment 1

Method

Thirty-six junior high school LD students attending public schools in a mostly white, middle-class western metropolitan area took part in this experiment. The 28 boys and 8 girls were all classified LD according to Public Law 94-142 and local school district criteria. They ranged in age from 11 years, 6 months, to 16 years, 0 months, with a mean age of 13 years, 11 months (SD = 11). Fifteen were 7th graders, 15 were 8th graders, and 6

were 9th graders. The mean Wechsler Intelligence Scale for Children-Revised (WISC-R) IQ was 94.4 (SD = 11.1). Mean California Achievement Test (CAT) reading percentile was 27.7 (SD=19.1). Students were stratified by grade level and randomly assigned to one of three treatment conditions: mnemonic, visual-spatial, and free study.

Materials. Ten minerals of North America, each with three associated attributes, were taken from the Scruggs et al. (1984) investigation and used for this study. Two of these minerals were sample items in all conditions, and the remaining eight minerals were used as target items. Each of the minerals selected represented a different hardness level, a different color, and a different use. The specific materials developed for each condition will now be described.

1. Mnemonic-instruction condition. Ten interactive illustrations drawn on 8-1/2 x 11 inch (22 x 28 cm) paper from the Scruggs, Mastropieri, Levin, and Gaffney (in press) investigation were used in this condition. Each illustration included the mineral name and its keyword, the hardness level and its pegword, the color (along with each keyword figure colored in the named color), and a representation of the mineral's use. For example, the illustration for teaching that apatite is No. 5 on the hardness scale, is brown in color, and is used for making fertilizer, is represented by an interactive illustration of the

keyword for apatite, ape. In this picture, a brown ape is dumping fertilizer on a hive (pegword for 5)--see Figure 1.

2. Visual-spatial display condition. A visual-spatial illustration depicting minerals, hardness levels, and uses was drawn on 8.5 by 11 inch (22 x 28 cm) paper for this study for both practice and target items. In addition, corresponding displays that included cells with information deleted for review purposes were included. The visual-spatial displays and accompanying experimenter scripts were modeled after the directions specified in Theory of Instruction (Engelmann & Carnine, 1982) and the samples in World of Facts (Engelmann, Davis, & Davis, 1981). Figure 2 displays the completed target item visual-spatial display. This display is very similar to the one proposed by

---

Insert Figure 2 about here

Engelmann and Carnine (1982, p. 165) for teaching specific attributes of metals. For example, the information was organized in a visual-spatial display that demonstrated the coordinate relationships of the minerals via the hardness levels. Notice that upon examination of the display, a learner could immediately infer that the minerals are arranged schematically according to hardness level from left to right. In addition, each lower cell contains information about the three specific attributes for each

mineral. The accompanying script began by stating: "This is a picture that will help you learn information about minerals [point to Space A]. This says minerals. What does Space A say?", and the script closely followed the proposed model by Engelmann and Carnine (1982).

3. Free-study condition. A typed 8-1/2 x 11 inch (22 cm x 28 cm) sheet listing the eight target minerals and associated attributes was provided. In addition, a typed list of the minerals and attributes was provided for the two practice items. Each student was also provided with a pencil and a blank sheet of paper.

Procedure. All students were administered the treatment individually by one of two experimenters. In addition, all students were told that they should try hard to learn some information about minerals, and that they would be given a quiz on the information at the end of the session. The condition-specific instructions were then administered to all students using the two sample items and a sample test. This was followed by the instruction on the target items, a 90-second "filler" interval, and the administration of the recall test. Students in all conditions received the same total amount of time with the sample and target items (about eleven minutes). Instructions for each experimental condition are now described.

1. Mnemonic-instruction condition. Students were first taught rhyming pegwords for the numbers 1 through 10 (1 is bun, 2

is shoe, 3 is tree, etc.). Next, they were taught keywords for the two practice items. They were then shown the interactive illustration for each practice item. The experimenter said the following, for example: "Apatite is 5 on the hardness scale, brown in color, and used for making fertilizer. The word clue for apatite is ape, and 5 is hive. Remember this picture of a brown ape pouring a bag of fertilizer on a beehive." Following this, students were asked to describe the illustration. Each illustration was displayed for 30 seconds. The experimenter then reviewed the retrieval process with the students. They were told that when they were asked, for example, "What number is apatite on the hardness scale?", they should first think of the word clue for apatite (ape) and then back to the picture with the ape in it and what was happening in the picture. They were told to find the pegword (hive) and respond with the appropriate number (5). They were also instructed to think back to the picture when asked for the color and the use. Following administration of the practice test, the eight target items were taught using the same procedure with the exception that the pegword counting system was not retaught. Each student was shown the target items in a different random order.

2. Visual-spatial display condition. Students were first taught the practice items by means of a experimenter-led visual-spatial display, direct-instruction, format modeled after the

World of Facts materials (Engelmann et al., 1981). The practice visual-spatial display (with two minerals, diamond and crocoite, in it) was shown, and the experimenter said, "This picture will help you learn information about minerals." Then the experimenter pointed in sequence to each lettered space, stated the information, and asked the student to respond appropriately. For example, learners were told that Space E said that crocoite was No. 2, orange in color, and used for displays. When all of the information had been presented, the corresponding visual-spatial display with empty cells was presented, and learners were asked what information belonged in each cell. Learners were prompted with the correct responses. After the training session, a quiz was given on the practice minerals. Following this, the eight target minerals were taught using identical procedures.

3. Free-study condition. Students were shown the sample study sheet and given a short time to study it independently. Students were informed that they could study the minerals in a variety of ways (such as writing down what they wanted with the provided pencil and paper, or covering parts of the list and self-testing), but that they should study in a way that would help them learn best. The experimenter reviewed the list with the student and offered to give assistance, if needed, throughout the study interval. After the study period, students were given a quiz on the two sample items. Following the quiz, the list target items

was given along with the same instructions as those used with the sample materials.

4. All conditions. As was mentioned previously, the total amount of instructional time was the same in all three conditions. However, because keyword learning in the mnemonic condition required one minute, students in the visual-spatial display and free-study conditions received approximately 25% more time directly learning the target minerals and their attributes. Immediately following the target item study period, all subjects were required to write their name, date of birth, grade level, and name of their homeroom teacher on a blank sheet of paper. This activity took 90 seconds. The attribute recall test was then administered to all students. The minerals were presented in a random order, and students were asked mineral by mineral: how hard the mineral was, what color it was, and what its use was.

Results and Discussion

Responses were scored correct if they consisted of the specific facts presented (e.g., apatite is No. 5, brown, and used for making fertilizer). Reliability of scoring was assessed at 100% by two independent scorers who were "blind" to experimental conditions.

The mean percentage of correct attribute recall in each condition is presented in Table 1. Pairwise comparisons between conditions were investigated using Tukey's multiple comparison

Insert Table 1 about here

procedure based on a familywise alpha of .05 (Kirk, 1982). The critical Tukey value, based on 33 error degrees of freedom and expressed as a *t* statistic, is equal to 2.46. In terms of total number of attributes correctly recalled (out of 24), mnemonic subjects statistically outperformed both visual-spatial subjects and free-study subjects, $t = 3.20$ and 3.46, respectively, both $ps < .01$. Total attribute recall of visual-spatial and free-study subjects was statistically equivalent, $|t| < 1$. Similar conditions profiles may be observed in Table 1 for the separate attribute categories of hardness, color and use (each based on eight items). For each attribute, the mnemonic mean appears to be higher than the two other means, which appear to be quite similar. In terms of statistical corroboration, Tukey multiple comparisons reproduced the same pattern on both the color and use attributes as was reported for the total. The differences in favor of the mnemonic condition on the hardness attribute were not statistically significant, $t = 1.29$ and 1.72 for mnemonic vs. visual-spatial and mnemonic vs. free study, respectively, both $ps > .05$.

Under the present experimental conditions, LD students recalled no more mineral attributes when the information was

presented in a spatially organized manner than when it was presented in a list for independent study. Although under some circumstances organizational pictures have proven to be effective with handicapped learners (e.g., Evans & Kerst, 1983; Levin, 1973; Mastropieri, Kulhavy, Lee, & Peters, 1982), in the present instance the type of visual-display proposed by Engelmann and Carnine (1982) was not effective. At the same time, students in the mnemonic condition learned more than twice as much information as did students in either the visual-spatial display or free-study condition. The findings generally replicate those of Scruggs, Mastropieri, Levin, & Gaffney (in press) in which mnemonic instruction proved to be superior to either direct instruction or free study in teaching attributes of minerals. The one exception was with respect to learning the hardness attribute where, in contrast to the Scruggs et al. results, the differences favoring mnemonic instruction were not statistically significant here. Informal experimenter reports suggest that unlike the mnemonic subjects in the earlier study, some of the mnemonic subjects here experienced difficulty in acquiring the numerical "pegword system" in the time allotted. This resulted in some degree of bimodality and increased variability in mnemonic subjects' hardness recall, which worked against detecting significant differences.

Experiment 2

The minerals chosen for Exp. 1 were associated with very

specific, unique attributes. That is, each mineral had its own three attribute values that were not shared by any of the other minerals. Although these representations conformed to the metals lesson proposed by Engelmann and Carnine (1982), it could be argued that the use of dichotomous attribute classifications might be better suited to the use of visual-spatial displays. In particular, the present minerals can be categorized as falling into one of eight mutually exclusive cells, as represented by the combination of their hardness (hard vs. soft), color (pale vs. dark), and use (home vs. industrial). A visual-spatial display is commonly used to present this type of taxonomic breakdown and, thus, might prove to be beneficial here. As far as mnemonic instruction is concerned, it has recently been shown that the present mnemonic approach can be adapted to facilitate LD students' learning of the dichotomized mineral attributes (Mastropieri et al., in press). Of specific interest in Exp. 2 was the relative utility of mnemonic vs. visual-spatial instruction applied to dichotomous attribute classifications by elementary-aged LD students. Again, a free-study control condition was included to provide a baseline against which to assess the effectiveness of each instructional strategy.

Method

Eighteen fifth graders and 18 sixth graders participated in the experiment. All students were classified as LD according to

local school criteria and Public Law 94-142. The 10 girls and 26 boys ranged in age from 10 years, 10 months, to 13 years, 7 months, with a mean age of 12 years, 1 month (SD = 8 months). The WISC-R IQs ranged from 80 to 119, with a mean of 99.0 (SD = 9.3). The mean CAT percentile for total reading was 26.1 (SD = 14.7). Students were first stratified by grade level and then randomly assigned in equal numbers to the three experimental conditions: mnemonic, visual-spatial, and free study.

Materials. Students in each condition were taught the same list of 10 minerals and dichotomized attributes taken from the Mastropieri et al. (1984) study. The three to-be-learned attribute dichotomies were hardness level (soft, which included minerals with hardnesses between 1 and 5; and hard, which included minerals with hardnesses between 6 and 10); color (pale and dark); and use (home and industrial). Each of the minerals of Exp. 1 fell into one of the eight mutually exclusive cells defined by the combination of these three dichotomizations. The two practice minerals of Exp. 1, with their dichotomized attributes, were also included.

The materials specific to each condition are now described.

1. Mnemonic condition. Mnemonic materials were taken from the Mastropieri et al. (1984) investigation. For each mineral and attribute combination, an 8-1/2" x 11" black-and-white line drawing was constructed. Each illustration showed the keyword

figure placed inside either a home or a factory scene (with home representing home use and factory representing industrial use), the keyword was interacting with either a baby or an old man (with baby representing soft mineral and old man representing hard mineral), and the keyword was either blackened in or not blackened in (blackened in for dark color, not blackened in for pale color). For example, the mineral apatite was depicted as a blackened-in ape with a baby in a factory scene (see Figure 3). The ape represents apatite, the baby represents a soft mineral, and the factory scene represents use in industry. In addition, the ape is blackened in to represent apatite's dark color. As a contrasting

---

Insert Figure 3 about here

---

example, quartz--a hard, pale mineral used in the home--was depicted as a pile of quarters (the keyword for quartz) in a home scene with an old man (see Figure 4). In addition, the quarters are not blackened in to signify that quartz is pale in color.

Insert Figure 4 about here

---

2. Visual-spatial condition. A visual-spatial illustration depicting minerals, hardness levels, and uses was drawn on 8-1/2" X 11" (22 cm X 28 cm) paper. This illustration was similar to

that used in Exp. 1, with the exception that the minerals were organized by soft versus hard, pale versus dark, and home versus industrial use. Relationships of the attributes were organized in a distinctive taxonomic fashion (see Figure 5). The accompanying script followed the model prepared by Engelmann and Carnine (1982). In addition, a visual-spatial display with cell information deleted was created for review purposes.

Insert Figure 5 about here

---

3. Free-study condition. Students in this condition were supplied with a single sheet of 8-1/2" x 11" paper that had the eight mineral names and associated attributes on it. Minerals were presented in a randomized order on the list. In addition, a typed sheet containing the two practice items was also prepared.

Procedure. All students were seen individually by one of two female experimenters in a quiet room in the students' school, and all were with the experimenter for an equal amount of time. The students were told they were about to learn some information about minerals, that they should try hard, and that they would be given a quiz on the information at the end of the session. The instructions specific to each condition will now be described.

1. Mnemonic condition. Students in the mnemonic condition were initially taught keywords for the two practice items. They

were then taught that a baby represented a soft mineral and an old man represented a hard mineral, and that a home scene or a factory scene represented the use of that particular mineral. In addition, they were taught that a nonblackened-in keyword figure represented a light-colored or pale mineral, whereas a blackened-in keyword figure represented a dark mineral. Following this, students were shown the two practice illustrations and taught how to retrieve the information. Then a practice quiz was given in order to allow the students to practice the retrieval process. Students were then taught the keywords for the eight target items. Immediately following this, students were shown each of the target illustrations for 30 seconds per picture and were told, for example: "Apatite is a soft mineral that is dark in color and used in industry. The word clue for apatite is ape, a soft mineral is a baby, and industry is a factory scene. Remember this picture of a dark ape swinging with a baby in a factory." The students were then asked to describe the picture. Following the presentation of all eight minerals, students were reminded of the retrieval steps and then tested for attribute recall.

2. Visual-spatial condition. Students in this condition were initially presented with a visual-spatial display of the practice items. Students were introduced to the practice information by means of the following lesson:

"This is a picture that will help you learn the information about minerals. [Point to appropriate space on the visual-spatial

display.] This says minerals. What does Space A say? Minerals can be hard or soft. Space B says hard minerals. What does Space B say? Space C says soft minerals. What does Space C say?"

"Minerals can be used in the home or used in industry. Space D says used in the home. What does Space D say? Space E says used in industry. What does Space E say?"

"So, hard minerals can be used in the home or used in industry, and soft minerals can also be used in the home or used in industry. Space F says used in the home. What does Space F say? Space G says used in industry. What does Space G say?"

"Minerals can be pale in color or dark in color. Space H says diamond is pale in color. What does Space H say? Now we know that diamond is a hard mineral, used in industry, and pale in color. [Point on visual-spatial display.] What do we know about diamond? [Prompt and point.] Space I says crocoite is dark in color. What does Space I say? Now we know that crocoite is a soft mineral that is used in the home and is dark in color. [Point.] What do we know about crocoite? [Prompt and point.]"

Students were then shown the blank visual-spatial display and directly questioned on the information that belonged in each cell. After feedback and practice, students were given a practice quiz. After the quiz, the experimenter showed the student the visual-spatial display and reviewed the items in the same manner as the practice minerals. First, prompting and questioning was given on

the visual-spatial display. Then, the visual-spatial display with empty cells was shown and the learner was questioned on the contents of the cells. When errors were made, they were corrected by the experimenter, who also showed the first visual-spatial display. After the allotted study time, the attribute test followed.

3. Free-study condition. Students in this condition were initially presented with a typed list of the two practice items and associated attributes. The experimenter explained that the typed sheet told the student the name of the mineral, whether it was soft or hard, whether it was pale or dark in color, and whether it was used mainly in the home or in industry. The experimenter then read through the list with the student (e.g., "This is apatite, it is soft, it is dark in color, and it is used in industry"). The experimenter then proceeded to tell the student a variety of ways that might be helpful for studying. These included reading the list over and over for rehearsal purposes, writing relevant information down, covering up part of the list and self-testing, and using any other methods that (s)he wished. Students were told to try hard, because when they were finished, they would be given a quiz. The students then were allowed to study the two practice items for a short time, followed by a practice quiz on them. Immediately following this, the students were provided the list of the eight target minerals and

their associated attributes. They were told that they would be given reading assistance if needed and were then allowed five minutes to study the list. Following this, they were administered the attribute recall test.

4. All conditions. The total amount of instructional time (eight minutes) was the same in all three conditions. However, because keyword learning initially took place in the mnemonic condition, students in the visual-spatial display and free-study conditions received approximately 25% more time specifically learning the minerals and their attributes. In all three conditions, immediately after the eight minerals had been studied, the subjects were asked to write their name, date of birth, grade level, and the name of their homeroom teacher, on an envelope. This "filler" activity consumed 90 seconds. Students were then administered the attribute recall test. On this test, the students were asked in order (mineral by mineral): whether the mineral was hard or soft, pale or dark, and whether it was used at home or used in industry. The minerals were presented in a random order different from that of the study list.

Results and Discussion

Responses were scored correct if they consisted of either the exact response (e.g., "soft" or "hard" for hardness level) or a close synonym (e.g., "light" instead of "pale" for color). Reliability of scoring was assessed at 100% by two independent

scorers who were "blind" to the experimental conditions.

The mean percentage of correct attribute classifications is presented in Table 2. For each attribute, "chance" performance is

---

Insert Table 2 about here

50%, assuming that each attribute's two labeled categories were available to all students. With this chance value in mind, one can see that across the three attributes, subjects in both the free-study and visual-spatial conditions did not recall a great deal of information (averages of 60% and 65%, respectively). In contrast, subjects in the mnemonic condition did (87%). As in Exp. 1, Tukey (familywise alpha = .05) comparisons revealed that total performance in the mnemonic condition was statistically superior to that in both the visual-spatial and free study conditions, t = 3.66 and 4.55, respectively, with performance in the latter two conditions not differing significantly $|t| < 1.2$

The findings of this experiment replicate those of Mastropieri et al. (in press) in that mnemonic instruction in dichotomous attribute classifications was found to be superior to other types of instruction, and extend these into the elementary grades. Moreover, as a replicating extension of the results of Exp. 1, once again the use of visual-spatial displays did not live up to Engelmann and Carnine's (1982) expectations. Although the

minerals were classified into only two categories for each of three attributes, and organized in a taxonomic manner that appears optimally suited for a visual-spatial display, students in the visual-spatial condition did not statistically outperform their free-study counterparts.

General Discussion

Taken together, the results of the present experiments support previous findings of mnemonic research with exceptional populations, and extend these findings into the upper elementary grades. In addition, the use of visual displays embedded in a direct-instruction teaching format did not prove to be significantly more effective than students' own independent study. As pointed out by Scruggs, Mastropieri, Levin, & Gaffney (in press), more careful analyses need to be made of the purposes and content of instruction when prescribing different instructional strategies. For example, mnemonic instruction has been consistently found to be the method of choice for rapid acquisition of novel factual associations. This is because the "three R" components of mnemonic strategies afford an unmistakably direct link between the "asked" and the "asked for" information. In the case of mineral attributes, for example, a mineral name leads directly to a concrete keyword, which leads directly to an integrated picture, which leads directly to the associated attributes. Other strategies (including visual-spatial displays)

may indeed be helpful for semantically organizing seemingly haphazard attribute information, but there is no built-in link between such organizations and the unfamiliar terms (here, mineral names) with which the subsumed information must be associated (see Levin, Shriberg, & Berry, 1983). Thus, whereas visual-spatial displays may readily clarify the specific attributes under consideration--and their relationship to one another--they do not afford memorable connections with the basically unfamiliar mineral names. As Levin (1982) has noted, nonmnemonic organizational strategies may well be effective under conditions where the associations "at the end of the line" are based on terms and concepts for which the learners already have background knowledge and experience, but that was certainly not the case with the apatites, corundums, and beryls of the present study. Also, Scruggs, Mastropieri, Levin, & Gaffney (in press) suggest that whereas mnemonic strategies are known to facilitate students' memory for facts, the "three operant R's" of direct instruction may well be optimally suited for acquiring basic procedural knowledge and skills--an hypothesis that is currently receiving research attention.

An argument can be made that the present visual-spatial display condition was not implemented as proposed by Engelmann and Carnine (1982), in at least four respects: First, this form of instruction is intended to be repeated over a period of several

days and to include game-like review activities. Although no research could be located involving this type of sustained activity with handicapped learners, it is possible that the benefits of visual-spatial displays would manifest themselves by, say, the fourth or fifth day of exposure. Note, however, that whatever success of visual-spatial displays could be hoped for in a longer-term instructional program has been achieved by mnemonic instruction after only one lesson. Thus, time and efficiency issues must be considered in any subsequent research comparing mnemonic- and direct-instruction approaches.

Second, visual-spatial displays have been proposed for use and discussion by small groups, in contrast to the individual administration applied here. As mentioned by Levin et al. (in press) in a related context, perhaps the value of semantic maps is in the cascading group-generated ideas and discussion that flow from them. Whether or not such involvement (and, perhaps, excitement) in idea production translates into learning gains has not yet been documented. Unfortunately, in the case of visual-spatial displays, what little evidence there is is based on a comparison that confounds treatments and classrooms (Darch & Carnine, 1981). Any future research that attempts to document the efficacy of group-administered visual-spatial displays must recognize the need for specifying "groups" as the "experimental units," and proceed accordingly.

Third, it can be argued that the present visual-spatial display, though spatially organized, was not pictorial. That is, no pictorial representations (illustrations or photographs) of the minerals--something that may have been beneficial or, at least motivating--were included. And, given that most minerals are unfamiliar to learners, use of mineral pictures in the display is justifiable. Again, in related contexts, it has been found that providing relevant pictures as motivational devices does not translate into enhanced learning when the acquisition of novel factual associations is involved (e.g., Levin, McCormick, Miller, Berry, & Pressley, 1982; Levin et al., 1983; Mastropieri, Scruggs, Levin, Gaffney, & McLoone, in press; Pressley & Levin, 1978). Moreover, Engelmann and Carnine (1982) are not at all consistent in their recommendations about the nature of "pictures" to be incorporated into visual-spatial displays. Indeed, certain types of pictures are said to be harmful, producing what they term "spurious" prompts (pp. 162-164); and of particular relevance to the present minerals lesson, the visual-spatial display was modeled directly after the one Engelmann and Carnine proposed for a lesson on the weights of metals, which did not include representational pictures.

Fourth and finally, although the visual-spatial approach did not prove effective with the present samples of handicapped (LD) students, they may nonetheless be more effective when used by

nonhandicapped learners. Curiously, in their book that is clearly targeted for teachers of handicapped learners, Engelmann and Carnine (1982) summarize the chapter on visual-spatial displays by starting out with: "For the more sophisticated learner, the visual-spatial display is an extremely efficient way to learn about systems" (p. 169, emphasis ours). Exactly why this statement appears in their book--and what it implies--is uncertain. Certainly, the related literature on the use of organizational pictures (outside of a direct-instruction format) does not support this "type of learner" caveat (e.g., Pressley & Levin, in press). Once again, additional controlled research is called for in order to substantiate such a claim.

In sum, although the results of the present study cannot be taken as evidence that visual-spatial displays are never effective, the exact circumstances under which these displays are effective remain to be specified. Meanwhile, the experimental evidence supporting the optimality of mnemonic instruction for enhancing the acquisition of facts and fact systems in both nonhandicapped and handicapped student populations continues to grow.

References

Atkinson, R. C., & Raugh, M. R. (1975). An application of the mnemonic keyword method to the acquisition of a Russian vocabulary. Journal of Experimental Psychology: Human Learning and Memory, 104, 126-133.

Becker, W. C. (1977). Teaching reading and language to the disadvantaged. Harvard Educational Review, 47, 518-543.

Becker, W. C., Engelmann, S., Carnine, D. W., & Maggs, A. (1982). Direct instruction technology: Making learning happen. In P. Karoly & J. J. Steffen (Eds.), Improving children's competence: Advances in child behavioral analysis and therapy (Vol. 1). Lexington, MA: Heath.

Carnine, D., & Silbert, J. (1979). Direct instruction reading. Columbus, OH: Merrill.

Dansereau, D. F., & Holley, C. D. (1982). Development and evaluation of a text mapping strategy. In A. Flammer & W. Kintsch (Eds.), Discourse processing, (pp. 536-554). Amsterdam: North-Holland.

Darch, C., & Carnine, D. (1981). Content area instruction: The role of information organization, learning strategies, and task structure. Unpublished manuscript, University of Oregon.

Engelmann, S., & Carnine, D. (1982). Theory of instruction: Principles and applications. NY: Irvington Publishers.

Engelmann, S., Davis, K., & Davis G. (1981). Your world of facts (Level 1). Eugene, OR: E-B Press.

Engelmann, S., Haddox, P., Hanner, S., & Osborne, J. (1978). Thinking basics: Corrective reading comprehension A. Chicago: Science Research Associates.

Evans, R. A., & Kerst, S. M. (1983, April). The effects of induced imagery and imposed synonyms upon prose comprehension. Paper presented at the annual meeting of the American Educational Research Association, Montreal.

Gersten, R. (1983). Direct instruction with special education students: A review of evaluation research. Unpublished manuscript, University of Oregon, Eugene.

Jensen, A. R., & Rohwer, W. D., Jr. (1963). The effect of verbal mediation on the learning and retention of paired-associates by retarded adults. American Journal of Mental Deficiency, 68, 80-84.

Johnson, D. D., & Pearson, P. D. (1978). Teaching reading vocabulary. NY: Holt & Co.

Kirk, R. E. (1982). Experimental design (2nd ed.). Belmont, CA: Brooks/Cole.

Levin, J. R. (1973). Inducing comprehension in poor readers: A test of a recent model. Journal of Educational Psychology, 65, 19-24.

Levin, J. R. (1981). On functions of pictures in prose. In F. J. Pirozzolo & M. C. Wittrock (Eds.), Neuropsychological and cognitive processes in reading (pp. 203-228). NY: Academic Press.

Levin, J. R., (1982). Pictures as prose-learning devices. In A. Flammer & W. Kintsch (Eds.), Discourse processing (pp. 412-444). Amsterdam: North-Holland.

Levin, R. R., Johnson, D. D., Pittelman, S. D., Hayes, B. L., Levin, K. M., Shriberg, L. K., & Toms-Bronowski, S. (1984). A comparison of semantic- and mnemonic-based vocabulary-learning strategies. Reading Psychology, 5, 1-15.

Levin, J. R., McCormick, C. B., Miller, G. E., Berry, J. K., & Pressley. M. (1982). Mnemonic versus nonmnemonic vocabulary-learning strategies for children. American Educational Research Journal, 19, 121-136.

Levin, J. R., Shriberg, L. K., & Berry, J. K. (1983). A concrete strategy for remembering abstract prose. American Educational Research Journal, 20, 277-290.

Lloyd, J., Cullinan, D., Heins, E., & Epstein, M. (1980). Direct instruction: Effects on oral and written language comprehension. Learning Disability Quarterly, 3, 70-76.

Martin, C. J., Boersma, F. J., & Cox, D. L. (1965). A classification of associative strategies in paired-associate learning. Psychonomic Science, 3, 455-456.

Mastropieri, M. A., Kulhavy, R. W., Lee, B., & Peters, E. E. (1982, April). Spatial organizers as schema for prose recall with learning disabled students. Paper presented at the annual meeting of the Western Psychological Association, Sacramento.

Mastropieri, M. A., Scruggs, T. E., & Levin, J. R. (in press). Direct instruction vs. mnemonic instruction: Relative benefits for exceptional learners. Journal of Special Education.

Mastropieri, M. A., Scruggs, T. E., & Levin, J. R. (1985). Memory strategy instruction with learning disabled students. Journal of Learning Disabilities, 18, 94-100.

Mastropieri, M. A., Scruggs, T. E., & Levin, J. R. (1983). Pictorial mnemonic strategies for special education. Journal of Special Education Technology, 6, 24-33.

Mastropieri, M. A., Scruggs, T. E., Levin, J. R., Gaffney, J., & McLoone, B. (1985). Mnemonic vocabulary instruction for learning disabled students. Learning Disability Quarterly, 8, 57-63.

Mastropieri, M. A., Scruggs, T. E., McLoone, B., & Levin, J. R. (in press). Facilitating the acquisition of science classifications in learning disabled students. Learning Disability Quarterly.

Pressley, M., & Levin, J. R. (1977). Developmental differences in subjects' associative-learning strategies and performance: Assessing a hypothesis. Journal of Experimental Child Psychology, 24, 431-439.

Pressley, M., & Levin, J. R. (1978). Developmental constraints associated with children's use of the keyword method of foreign language learning. Journal of Experimental Child Psychology, 26, 359-372.

Pressley, M., & Levin, J. R. (in press). Elaborative learning strategies for the inefficient learner. In S. J. Ceci (Ed.), Handbook of cognitive, social, and neuropsychological aspects of learning disabilities. Hillsdale, NJ: Erlbaum.

Pressley, M., Levin, J. R., & Delaney, H. D. (1982). The mnemonic keyword method. Review of Educational Research, 52, 61-91.

Raugh, M. R., & Atkinson, R. C. (1975). A mnemonic method for learning a second-language vocabulary. Journal of Educational Psychology, 67, 1-16.

Rowher, W. D., Jr., Raines, J. M., Eoff, J., & Wagner, M. (1977). The development of elaborative propensity in adolescence. Journal of Experimental Child psychology, 23, 472-492.

Rosenshine, B. (1979). Content, time, and direct instruction. In P. L. Peterson & H. J. Walberg (Eds.), Research on teaching: Concepts, findings, and implications. Berkeley, CA: McCutchan.

Scruggs, T. E., & Mastropieri, M. A. (in press). Spontaneous elaboration in gifted and non-gifted youths. Journal for the Education of the Gifted.

Pressley, M., & Levin, J. R. (1978). Developmental constraints associated with children's use of the keyword method of foreign language learning. Journal of Experimental Child Psychology, 26, 359-372.

Pressley, M., & Levin, J. R. (in press). Elaborative learning strategies for the inefficient learner. In S. J. Ceci (Ed.), Handbook of cognitive, social, and neuropsychological aspects of learning disabilities. Hillsdale, NJ: Erlbaum.

Pressley, M., Levin, J. R., & Delaney, H. D. (1982). The mnemonic keyword method. Review of Educational Research, 52, 61-91.

Raugh, M. R., & Atkinson, R. C. (1975). A mnemonic method for learning a second-language vocabulary. Journal of Educational Psychology, 67, 1-16.

Rowher, W. D., Jr., Raines, J. M., Eoff, J., & Wagner, M. (1977). The development of elaborative propensity in adolescence. Journal of Experimental Child psychology, 23, 472-492.

Rosenshine, B. (1979). Content, time, and direct instruction. In P. L. Peterson & H. J. Walberg (Eds.), Research on teaching: Concepts, findings, and implications. Berkeley, CA: McCutchan.

Scruggs, T. E., & Mastropieri, M. A. (in press). Spontaneous elaboration in gifted and non-gifted youths. Journal for the Education of the Gifted.

Scruggs, T. E., Mastropieri, M. A., & Levin, J. R. (in press). Vocabulary acquisition of retarded students under direct and mnemonic instruction. American Journal of Mental Deficiency.

Scruggs, T. E., Mastropieri, M. A., Levin, J. R., & Gaffney, J. (in press). Facilitating the acquisition of science facts in learning disabled students. American Educational Research Journal.

Sprick, R. S. (1979). A comparison of recall scores for visual-spatial, visual-serial, and auditory presentation of intermediate grade content. Unpublished doctoral dissertation, University of Oregon, Eugene.

Tolfa, D. (1985). Effectiveness of extended mnemonic instruction with learning-disabled students. Unpublished doctoral dissertation, Utah State University.

Footnotes

The second author's contribution was funded in part by a postdoctoral fellowship through the Developmental Center for Handicapped Persons at Utah State University, and the third author received funding from the National Institute of Education through the Wisconsin Center for Education Research. The authors would like to thank Dr. Hal McGrady and the Special Education personnel from the Mesa Public schools for their assistance in the project. Thanks are also due to Joe Gardner for his artwork and to Ursula Pimentel and Mary Ellen Heiner for typing the manuscript.
Requests for reprints should be sent to Dr. Thomas E. Scruggs, Developmental Center for Handicapped Persons, UMC 68, Utah State University, Logan, UT 84322.

[1]Here and throughout this paper, the term "visual-spatial display" refers to a figural display embedded in a direct-instruction teaching format, developed according to Engelmann and Carnine's (1982, Chapter 14) guidelines.

[2]As in the Mastropieri et al. (in press) study, analysis of the three separate attributes (each based on eight items and a "chance" value of 4.0) was not conducted because of skewness arising from apparent ceiling effects associated with the mnemonic condition, and because of the grossly unequal variances that resulted in the three conditions. These problems were alleviated somewhat in the across-attribute total scores.

[3]Recently, mnemonic instruction of similar aged LD students has been compared with visual-spatial display instruction in which pictures of target responses were incorporated into the display, with results equivalent to those presented here (Tolfa, 1985).

Table 1
Mean Percent of Correctly Recalled Attributes in Each Condition

Condition	Attribute			
	Hardness	Color	Use	Total[a]
Mnemonic	47.9	71.9	55.9	58.3
Visual-spatial	32.3	29.2	24.0	28.5
Free-study	27.1	25.0	26.0	26.0

[a] $MS_E = 524$

Table 2
Mean Percent of Correctly Recalled Attribute Classifications in Each Condition

Condition	Attribute			
	Hardness	Color	Use	Total[a]
Mnemonic	77.1	90.6	92.7	86.8
Visual-spatial	62.5	71.9	61.5	65.3
Free-study	61.5	63.5	55.2	60.1

[a] $MS_E = 207$

Figure Captions

Figure 1. Mnemonic representation of specific attributes of apatite (Ape colored brown in original).

Figure 2. Visual-spatial display for specific minerals attributes.

Figure 3. Mnemonic representation of dichotomous apatite attributes.

Figure 4. Mnemonic representation of dichotomous quartz attributes.

Figure 5. Visual-spatial display for dichotomous mineral attributes.